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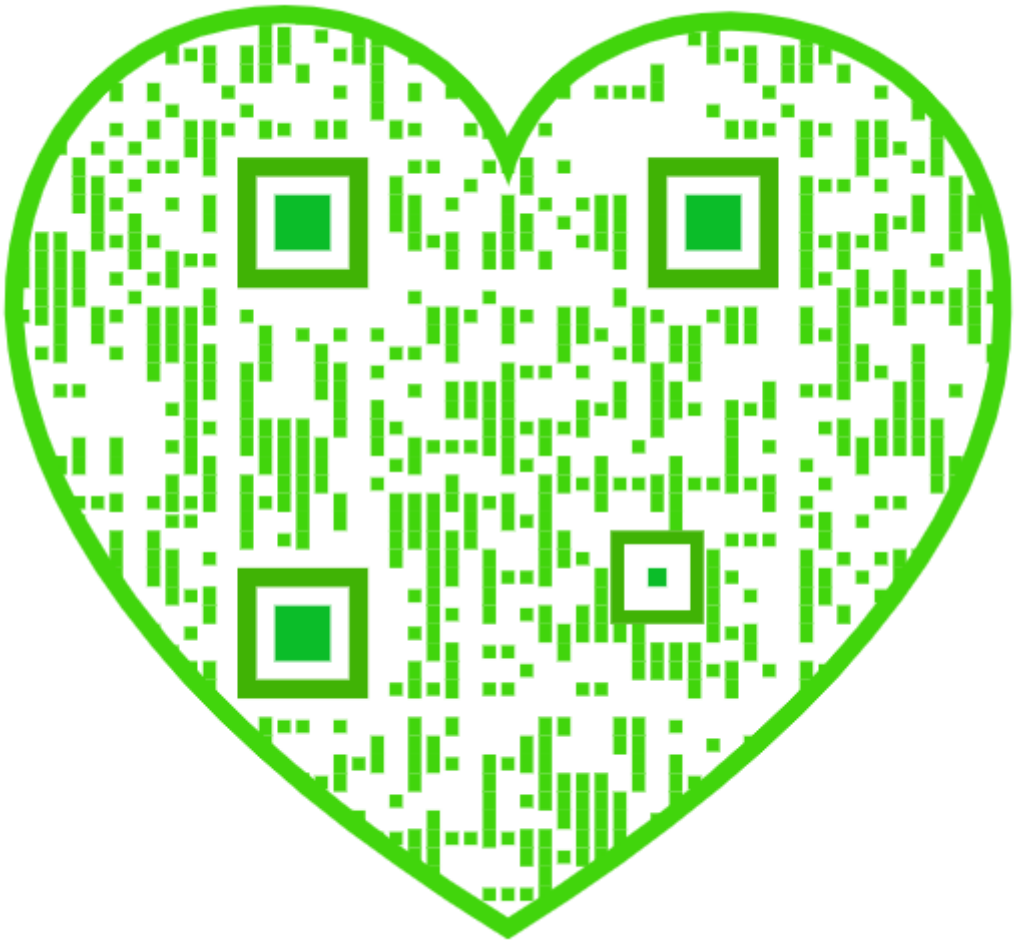

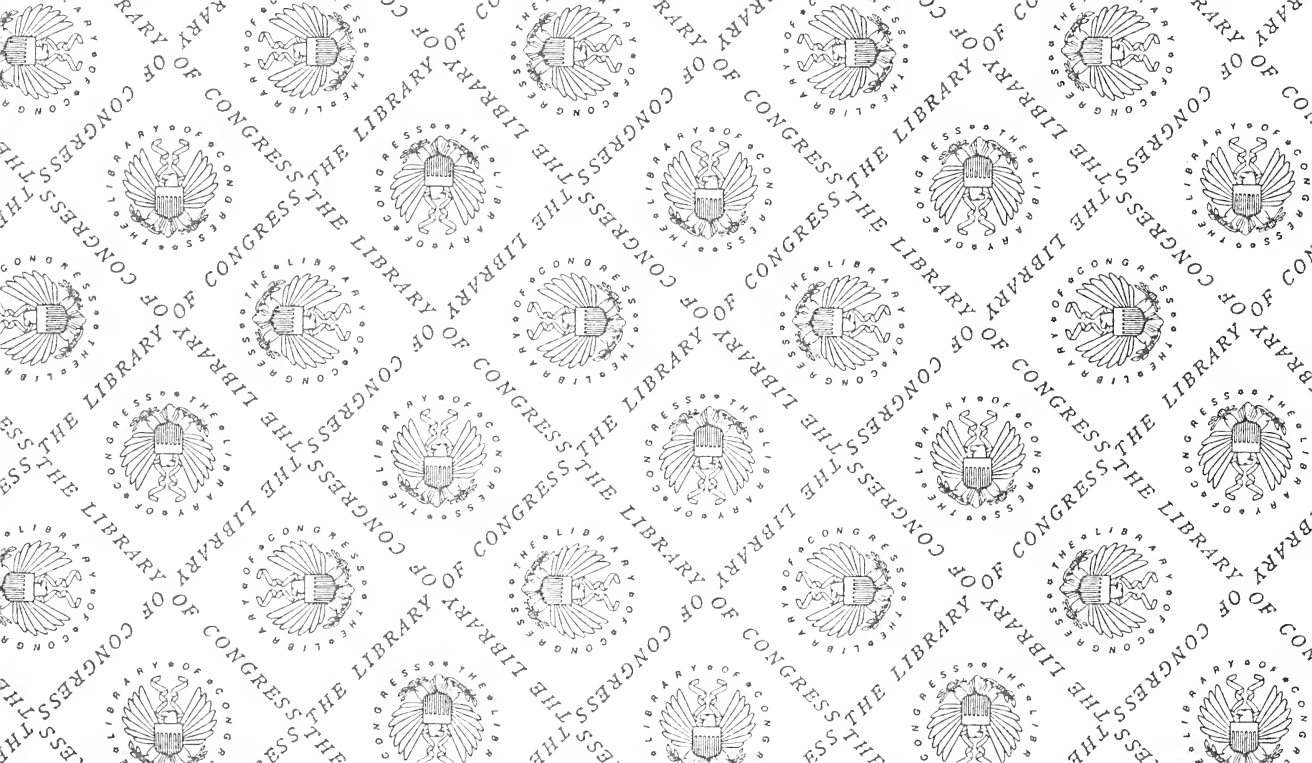
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SILK CULTURE.

A HAND-BOOK

FOR

SILK-GROWERS.

BY

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PREFACE.

It is the purpose of this little hand-book to aid in creating an interest in silk-culture, and to afford a guide to those who desire to practically undertake raising the silk-worm.

From a general study of the subject, from practical experience, and from many authentic sources, the facts here presented have been compiled; and the writer desires that the dissemination of them may prove useful, and that the growing of raw silk in the United States may become general, and add to individual and national prosperity.

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SILK CULTURE.

CHAPTER I.

THE MULBERRY.

The first important work in practical silk-culture is, to provide an abundance of nourishing food for the future army of silk-worms. Worms fed upon the leaves of the Osage Orange, may produce inferior silk, and lettuce or dandelion leaves may prevent the worms from perishing with hunger; but, unquestionably, the natural and proper food for the silk-worm, its "staff of life," is the Mulberry.

The Mulberry tree is of the genus *Morus*, which comprises perhaps a dozen species. The White Mulberry, *Morus alba*, stands at the head of the list, as it has proved more suitable for producing the finest silk, and for withstanding the frosts of winter, than most other species.

The *Morus multicaulis* is vigorous in growth; its leaves are coarse and large, and it is easily propagated from cuttings.

The *Morus Japonica*, or Japanese Mulberry, stands the cold well, and its large leaf recommends it to the silk-grower.

An improved variety of *Morus alba,* called *Moretti elata,* is said to endure hard frosts, and its large, thick leaves make it desirable. Cultivators differ in opinion in regard to the value of the different varieties of the Mulberry; but the "White" is generally preferred in Italy, and in the United States. Mulberry trees are in full bearing when four or five years of age. They have the reputation of usually resisting the extremes of heat and cold. A sheltered position might aid in shielding the trees from frost, but their depth of root helps them to resist the drouth of summer.

The Mulberry requires that the soil should be deep, light, and rich, and it seldom thrives well in clay or sand. Light, loamy soil, however, well plowed, and with a southern exposure, is favorable to the growth of the tree. For convenience in picking the leaves, the trees should be planted near the home of the silk-culturist, and they may be made useful as a hedge, or as shade trees, in any unoccupied space.

Mulberry trees may be grown either from seed, or from cuttings: and grafting is sometimes practiced; but some think, that trees not grafted, yield the best silk, although in smaller quantities.

If trees are planted in rows, the rows may be ten or twelve feet apart, some say eight feet apart, and the trees six or eight feet from each other in the row. When the plants are young, irrigation may hasten their growth; but freely-watered trees do not produce as rich material for making silk, nor are the leaves as nutritious or healthful for the worms, therefore water should be used sparingly.

In Italy, the Mulberry is often planted in grain fields, or other cultivated lands, and about eighty trees allowed to an acre. The trees produce leaves for from fifty to one hundred years, according to the soil and climate. It is estimated that, in two or three years from planting,

a tree will yield about ten pounds of leaves, and it requires twenty pounds or more of leaves, to produce one pound of silk cocoons.

Cuttings may be six or eight inches in length, each having a bud or eye near the top. In rich soil, the cuttings may be placed where they are expected to grow, and almost covered with earth. Weeds must be kept down, and the ground worked with plow or hoe.

In planting a large grove of Mulberry trees, roadways should be left so that the leaves and branches need not be carried far by hand to a place of deposit.

Mulberry trees left to themselves, usually grow to the hight of from twenty to forty feet; but for convenience in gathering the leaves, the trees should be pruned, and not allowed to grow to a hight of more than ten or twelve feet. This pruning may be done each year, or every other year, in the fall months, after the leaves have fallen. The trees may be planted in either fall or spring, although the latter time is preferable.

Ten or twenty trees are sufficient for a first experiment in silk culture, and the writer proved that three trees of two years' growth, produced sufficient leaves for one hundred worms, from the time of hatching until they spun.

One acre of land may easily contain four hundred trees, and feed the silk-worms from several ounces of eggs. Some one has estimated that a good rich acre can be made to yield food enough for one million silk-worms. But no precise estimate can be made, because so much depends upon the number of trees to the acre, also the hight they are allowed to grow, the quality of soil, the climate, and the economy or prodigality of those who gather the leaves and feed the worms.

It might pay the farmer to plant groves of Mulberry for the purpose of selling the leaves and branches to people in towns who desire to raise the silk-worms, but who have no land upon which to raise the necessary food.

Millions of worms might be raised in this way in cities, and prove a benefit to both town and country.

If it is desirable to raise trees in a nursery, the cuttings may be placed four or five inches apart, and transplanted the third year.

When pruning trees, all dead branches should be removed and the trees kept in a trim and healthy state. The pale green of the Mulberry is pleasing to the eye, and the wood is good for fencing, and for use by the cabinet-maker. The fruit which grows upon the Mulberry is readily eaten by poultry, while cattle are said to thrive upon the green leaves.

The work of gathering leaves from the Mulberry is not nearly so much as that required in picking the small leaves of the Osage Orange, and the price of silk made from Mulberry is greater than that from the Orange.

CHAPTER II.

GATHERING THE LEAVES.

The tiny worms must be supplied with leaves immediately after hatching, or they will wander off and get lost. Only small leaves, or tender larger leaves, should be gathered for the young worms. The reddish leaves must never be given to worms, as they sicken and injure them. Damp leaves must never be given to silk-worms of any size or "age."

In rain-storms, the leaves must be dried, or thoroughly wiped, before presenting them to the worms. Stale and withered leaves, the worms will never eat. Twigs and branches may be given to feed from, when the worms are older. A sufficient number of branches should never be taken from one tree, to disfigure or injure it. The

branches should be taken off evenly, all over the tree, so that a good head may appear another season. Trees are sometimes, however, wholly stripped of leaves, without apparent injury. Pruning-shears may be used for cutting twigs and branches. These branches need not be lost, for, with care in planting, they will grow after the worms have eaten the leaves. The worms dislike a flat surface, after they are of any considerable size, therefore the twigs and branches are more agreeable to them. They keep the worms from being crowded in among the débris, and allow them more air, of which they need an abundance.

If kept as warm as they should be, the worms eat most freely early in the morning, and late at night; this is especially so with worms of the "fifth age." Leaves for the morning should be gathered the night before, and kept in a cool room. If not gathered until morning, the leaves are covered, usually, with dew. Silk-worms are enormous eaters, and should not be stinted for food. Mr. Bonafoux estimated that one ounce of worms (forty-thousand) would eat leaves at the following rate:

The "first age"	7	pounds of leaves.
" "second age"	21	" " "
" "third age"	69	" " "
" "fourth age"	200	" " "
" "fifth age"	1,250	" " "
Total	1,547	pounds of leaves.

The weight of silk-worms is estimated by Count Dandolo as follows, for one hundred newly-hatched worms:

Weight at first	1 grain.
After first moult	15 grains.
" second moult	94 "
" third moult	400 "
" fourth moult	4,623 "
Full size	9,500 "

All this gain in weight is made in from thirty-two to thirty-five days.

CHAPTER III.

THE COCOONERY.

The cocoonery, or feeding-room, may be large or small, according to the number of worms to be accommodated. In very warm countries, an airy, open building often serves the purpose, but a closed room is usually needed in the United States. An attic, or any unused room, will do, if it is dry, light, and has good ventilation. It is stated that the peasants of Europe often clear out as many of their living rooms as possible for the few weeks necessary to raise the silk-worm, and then re-occupy them when the spinning of the worm is over.

When houses are built on purpose for the business, they should be twice as long as they are wide, with windows on each side for air and light; but the direct rays of the sun upon the worms should be avoided, as it will sometimes kill them. Upright frames may be made to hold the number of trays desired for the worms. The trays may be eighteen by twenty-four inches, with a border of seasoned wood, to prevent the worms from falling off. They should be lined with paper, which should be changed daily. Perhaps a better way is, to use mosquito netting for the bottom of the tray, supporting the worms and leaves by strong twine fastened to tacks beneath the netting. This netting must be taken off and aired often, other netting being supplied meantime. For the first two weeks, such a tray will answer for feeding eight hundred worms. As the worms grow very fast, care must be taken to place them on other trays, that they may not crowd too much.

It has been estimated by an experienced silk-grower, that a room twenty-four feet by sixteen, and eleven feet in hight, from floor to ceiling, is sufficiently large for fifty-thousand worms, and that a man or woman, with

the help of several children, to pick the leaves, can care for that number with ease.

A temporary cocoonery which the writer visited, was in charge of one man, who with the aid of children, was raising seventy-five thousand silk-worms. There were four or five wooden frames, extending nearly the length of the room, with aisles between the frames, and in hight the frames nearly reached the ceiling. The silk-worms were feeding and resting upon cheese-cloth shelves, which were about four or five feet in length, by three wide. The cloth shelves were supported by strong cord, stretched lengthwise and then crosswise beneath them, the cord being fastened to the framework at the sides and ends. Boards for shelves are not used. Coarse cloth or netting allows the worms purer air.

There were three or four cloth shelves to the length of one frame, and they were also placed one above another to the number of four, leaving a space between them, to allow the attendant to easily feed and care for the worms. The silk-worms were in all stages of growth. Upon a later visit, the children were picking the cocoons and stripping off the floss-silk, and then dropping the cocoons into baskets. Many silk-worms were spinning upon rough frames, or upon dry branches of oak. Each frame was made of three ordinary laths, of the usual length, and in the shape of a triangular prism. Each side of the triangle, at each end of the laths, was about four inches in length. The roughness of the laths seemed to aid the worm in attaching its silken threads. The frames were made as an experiment, but found to work well. They were fastened to the corners of the cloth shelves, the lower ends resting on the shelves. When the spinning was over, the frames were easily taken down, and the cocoons removed from them.

FRAME.

When only a few worms are raised, just for experiment, two or three trays or shallow paste-board boxes upon a table in the corner of a sitting-room, are all that need be required. Fifty worms raised thus, in a family of growing children, may awaken in the "dull boy" a taste for natural history, which books alone could not do; and the mother may lead the child to adore the wisdom of God, who so fashioned the silk-worm that it can make silk from a green leaf.

One authority, Count Dandolo, has estimated, that the space needed by one million silk-worms, is as follows:

The "first age,"	200	square	feet	of surface.
" "second age,"	375	"	"	"
" "third age,".....	875	"	"	"
" "fourth age,".....2,062		"	"	"
" "fifth age,".....5,000		"	"	"

Thus requiring a cocoonery of two stories to be thirty-five by seventy feet.

It is stated that in China the cocoonery is often but a bamboo house, with curtained windows, standing at one end of a silk farm, and the trays resemble little sieves, which stand upon upright frames. The little girls are early taught to pick the Mulberry leaves from the many rows of low trees, and carry them in baskets to the cocoonery, where they quietly feed the worms, and learn how to care for the silk-worms at a very early age.

CHAPTER IV.

EGGS OF THE SILK-WORM MOTH.

The eggs of the moth are nearly round in form, slightly indented on the faces, and about the size of the head of a common pin. At first they are yellowish in color, but when fertilized, they become in a few days or weeks, of a grayish hue, or sometimes of a lilac or greenish color, according to the variety of the silk-worm.

The eggs are usually called by silk culturists, "seeds," or "grain." The "grain" is preserved upon portable substances, such as cloth or paper, to which the eggs adheres by means of a natural gluey substance, or gum. The eggs should be kept in a very cool, dry room, at, say, thirty or forty degrees, or lower, until the Mulberry puts forth its leaves, thus signaling that the hatching season draws nigh.

Then the eggs should be introduced very gradually into a warm temperature, until seventy-five or eighty degrees are reached, when they will gradually hatch in from three to ten days. The "annual" worms hatch usually in April or May. There should be some means of keeping the cocoonery or feeding-room, at from seventy-five or eighty degrees, night and day, during the whole existence of the worm.

As the time approaches for hatching, the eggs become lighter in color, a very slight clicking sound may usually be heard from within, and early some morning the tiny worms begin to crawl out of their little prisons. Without experience, one would suppose the white egg contained a white worm, but no; out they come, one after another, and all are as black as night, and are looking about for food.

The just hatched silk-worms are but one or two lines in length, but their growth is very rapid. All worms

that hatch upon a single day, should be kept by themselves, and not placed in the same tray or on the same shelf with those hatched the day before. Otherwise, the worms will not all moult at the same time, and the feeding worms will disturb those that are sleeping.

It is estimated that one ounce of eggs, or forty-thousand worms, will produce one hundred pounds of fresh cocoons, or thirty pounds of stifled, dried cocoons. Growers should raise their own eggs for "seed," and the eggs must be free from disease, or the worms will probably die. Should disease break out, the sick and dead worms must be destroyed, and the trays thoroughly washed, scalded, and diluted carbolic acid, or fumigation may be used for cleansing the trays.

CHAPTER V.

FEEDING THE SILK-WORMS.

The amount of silk produced by silk-worms depends largely upon the quantity and quality of food they consume, from which to manufacture the silk. Therefore it is of the greatest importance that leaves of the proper kind, and in sufficient quantity, should be within their reach at all times. Six, or even eight, times during the twenty-four hours, fresh food should be placed before the worms. They rather skillfully gnaw the leaves in little circles, and sometimes leave only the skeletons behind.

Leaves that are dusty, must be cleaned before feeding them to the worms, and the greatest care is necessary in regard to cleanliness, and in respect to good ventilation and an even temperature in the feeding room. Draughts should be avoided, and food should never be laid over the silk-worms in such a manner that they will suffocate

from want of fresh air, or become crushed from the weight of leaves. A good way is, to lay the branches lengthways and crossways.

Dried leaves and excrements, also the cast-off skins, should be removed from the trays daily, and no tobacco-smoke or other unpleasant odors allowed to penetrate the feeding-room.

Dead or diseased worms must be burned, that their presence may not injure the healthy worms. Some worms will die at every moult, and will be found among the dried leaves and litter. It should be very strongly impressed upon all silk culturists, that extreme cleanliness and great care, are necessary to the health of silk-worms.

It is not well to handle silk-worms; but when it is necessary to remove them from one tray to another, it may best be done after they have crawled upon fresh branches. In feeding, when the worms are small, mosquito netting may be placed over the worms, and fresh Mulberry leaves upon the top of it. The worms will soon crawl through the meshes to the fresh food; then they may be removed on the netting to a clean tray, and the litter cleaned from the one the worms have left.

When the worms are larger, paste-board, or paper perforated with sufficiently large holes for the worms to crawl through, may be substituted for the netting.

Leaves of peach, or any other kind of fruit tree, must never be carelessly mixed with the Mulberry leaves. Some fruit trees leaves are poisonous, if fed to and eaten by the worms.

Insects, such as ants, and spiders, must not be allowed in the feeding-room, and birds, rats, and mice, will devour silk-worms or cocoons, if possible.

A thermometer is necessary in regulating the temperature of the feeding-room. Well-fed worms, and those kept at a temperature of seventy-five degrees, will mature quicker and are less liable to disease, than those that are

but half-fed and kept in a colder room of sixty degrees. However, the heat should never exceed eighty degrees. If worms have sufficient food, they are not disposed to wander away from it, excepting when they are just ready to spin their cocoons.

A company of "fifth-age" worms, while feeding, make a low, munching sound with their strong jaws, which may be heard across a large room. But, as they make no other audible sound during life, this noise is rather pleasant than otherwise. No mouldy odor should cling to the trays, or be allowed in the feeding-rooms.

CHAPTER VI.

MOULTING.

The moulting time is a serious period in the lives of the worms. It is very important that sharp, quick noises should be avoided in the feeding-room, and that no unusual sounds should be heard by the little sleepers. Severe thunder-storms have been known to so frighten them at the time, that they have perished.

Silk-worms pass through four sleeping spells, or moults. In four or five days from hatching, they crawl upon an elevated portion of a leaf, fasten themselves by the hindmost legs, raise their heads in the air, and remain in this position, if not disturbed, for from twelve to thirty hours. When they awake, they leave their black coats upon the dried leaves, and come out dressed in lighter colored ones. Their coats are lighter after each successive moult, and after the last one, is of a yellowish-white color.

The skins that are cast, often preserve the shape of the head, legs and other parts of the body, so much so, as

sometimes, in the fourth moult, to be mistaken for the worm itself. These skins should be destroyed with the rest of the litter. Doubtless, the silk-worms feel relieved on getting out of the old skins that have become too small for them, and after each moult they hasten to their Mulberry food with increased appetite.

The periods between the moults are called "ages," therefore a silk-worm is spoken of as being in the "second age," "fifth age," etc. The length of the "ages" vary from five to seven days, however; the "fifth age," or last one, is nine or ten days long.

Moulting should not be mistaken for disease; sometimes the worm may turn of a dark color and appear sick, before sleeping.

These stated periods are usually given as follows:

From hatching to the first moult	from 5	to	6	days.
" first to second moult	" 4	"	5	"
" second to third moult			5	"
" third to fourth moult			6	"
" fourth moult to spinning	from 8	to	10	"

In too cold a temperature, the life of the worm may be prolonged several days, but the usual length is from thirty-two to thirty-five days. From hatching, until the cocoons are all dry enough for the filature (or reeling), is a period of about three months.

The fourth moult is the most serious, and silk-worms that have not had good previous care, are likely to die at this time.

CHAPTER VII.

SPINNING.

At length, at the end of from thirty-two to thirty-five days, the silk-worm is fully grown. It is now three inches or more in length, of a greenish or yellowish-white color, with dark markings, and a fleshy protuberance on the last joint but one. Its body has twelve segments, nine stigmata or breathing holes on each side, and a double row of legs, numbering sixteen in all.

Although the worm has so many legs, it finds use for them all when it begins to spin. While some support its body, other legs are used, sailor-like, in hauling the silken ropes in a skillful manner. The anterior six legs are hooked, while the others end off in disks. The mouth is opened vertically, and the jaws are serrated (saw-toothed), and very strong.

A day or two before the worm commences to spin its cocoon, its desire for food abates; it nibbles the leaves without seeming to have an appetite for them; it is restless, and runs hither and thither, looking upward frequently as though searching for a quiet haven among the branches to weave its nest, and then, wrapping "the drapery of its couch about itself, lies down to pleasant dreams."

The worm should now be provided with something to spin in, or upon, and many things will answer for the purpose. Clean bunches of straw, set upright, twigs, and small bundles of tree-branches two or three feet long, may be laid upon the shelf; paper cones, or small, square pasteboard boxes may be used for them to spin in. On finding itself within a limited space, in a cone, for instance, where the walls may be touched on all sides by its head, the worm carefully inspects every corner, and, at length, with an air of satisfaction, fastens its first

silken rope, as a guy, to a selected spot. The silk issues from two ducts situated one on each side of the jaws of the worm. The vibratory motion of the head, causes the two threads to unite and appear to the unaided eye like a single thread.

The worm twists its body in the shape of the letter S, while spinning, and it is not long in attaching its threads to all sides of its new cell. Within this outer floss-silk is spun the cocoon. Gradually, the worm is hidden from sight, and in from three to five days the cocoon is finished. While spinning, the worms should be kept separate, that they may make no double cocoons which cannot be reeled. However, they are just as good for seed. No draughts of air should come upon the worms while spinning, lest the fluid from which the silk is formed may congeal, and interfere with this important work. The temperature should be kept up the same as when they were eating, at seventy-five or eighty degrees.

The cocoon is made entirely of silk, covered with a yellowish gum. The silk threads of cocoons are of different lengths, but are usually one thousand or twelve hundred feet in length, as found by measurement in reeling. When finished, the cocoon is an inch or more long, of a white, green, or yellow color, according to the kind of silk-worm. On account of its being covered with a gummy substance, the cocoon is impervious to cold water. This provision was necessary in the native state of the worm, to protect it from injury by the rain.

The cocoon is not so long as the worm was before spinning, because in part, of its having spun itself away, and in part, because the worm, as it spins, curls itself up almost double. The yellow cocoons resemble in size and color the common peanut; the depression in the center of many cocoons is also very similar to that in the center of the shell of the peanut.

The worms that do not commence spinning so quickly

as the majority have done, should be placed in another tray and still fed. There are always some laggards, and they should be protected from the greenish fluid usually discharged by worms before spinning.

Silk-worms are very docile until spinning time comes; then they wish to select their own places for spinning, but with a little care they are easily controlled.

The worms do not wind the silk round and round the cocoon, as silk is wound on a spool; but when spinning, their heads are moved back and forth from right to left, and, *vice versa,* from left to right, constantly; in this way they nicely fold the silk in the shape of the figure 8.

The worm gradually hides itself from view as it spins inside of its cocoon, and in about three days the spinning is completed and the worm then changes into a chrysalis.

A very ornamental bouquet, for displaying at fairs, etc., may be made from cocoons. One seen by the author, recently, had as a base a board of about two feet in length, by one in width. Perhaps one hundred holes in the board were filled with leafless tree branches, about three feet in length, standing upright. Silk-worms had been induced to spin their cocoons all over and through the branches, fastening them together with the silken floss, and presenting a beautiful bouquet, designed by man, but ornamented by the silk-worm. Fifteen hundred cocoons were clinging to these branches by silken cords. Two other bouquets of smaller size, made in like manner, stood upon either side of the large bouquet, and golden, shining skeins of silk, together with numerous spools of silk, in all colors, were on exhibition, thus presenting a novel spectacle, and one of which any silk culturist in the United States might justly be proud.

In all cocoons there are three or four distinct layers of silk of different degrees of fineness. Some think that these correspond to the four moults of the worm.

CHAPTER VIII.

THE COCOONS.

In a few days the cocoons harden, and good ones have a firm feeling when handled. Those intended for raising eggs should be stored away in a safe place, but not entirely excluded from air. The lightest-colored and firmest cocoons are usually best, and an equal number of each sex should be selected, if possible, for eggs.

The female cocoon is generally larger, and more round in form, while the male cocoon is slender, pointed somewhat at the ends, and depressed in the middle.

When the cocoons are intended for reeling, the moths must not be allowed to pierce the ends, for this would tear the threads and so injure the silk that it could not be reeled off. If the reeling cannot be done immediately, it is necessary to "stifle," or destroy, in some way, the lives of the poor little prisoners.

Stifling is generally done by dry heat, or by means of steam. Heating them in an oven, will surely kill them; but it is thought that dry heat injures the glossy appearance of the silk, therefore steam is oftener resorted to for this purpose. It takes one hour; but a half hour more will be more likely to insure success. The cocoons are placed in a wicker basket, covered with thick flannel, and suspended just above a vessel of boiling water (a wash boiler will answer), until the chrysalides are all killed. Then the cocoons must be spread out to dry, in a shady place, where the air is good, and where there is no danger from insects or mice, and they must be stirred and turned occasionally, until dry. In three or four weeks the cocoons may be gathered, tied up in coarse bags, and sent to the filature or hung up in a dry place. When shaken, the dry cocoons may be heard to rattle like peas in a pod. When one is opened, a homely specimen of

natural history is presented. It little resembles the white worm that entered the cocoon. Indeed, the chrysalis reminds one of an Esquimaux child, swaddled up from head to boots in a dress of one piece. It is difficult to cut open a cocoon with a case knife, because the silk is strong and covered with gum. Scissors will, however, cut one open very readily.

Never shake a cocoon that is intended for seed. Care should be taken not to crack or dent the cocoons that are to be reeled. In gathering them from the place where they have spun, pick off the outer floss silk. This is called "stripping." The floss silk and "pierced" cocoons may be sold for poor silk. The pierced cocoons are those that have been opened at one end by the moth, when coming out.

In gathering, keep the dark and stained cocoons separate from others. Where the insect has died, the cocoon is sometimes discolored, and may be burned. Soft cocoons should also be rejected, as in packing they may break and injure others.

Un-pierced cocoons are usually sold at from one dollar to one dollar and a half per pound. All cocoons intended for market, must be properly stifled and well dried, or great loss may be experienced from mildew. Expense is avoided in shipping cocoons by packing in coarse bags, but barrels or boxes may be used for the purpose; and, if sent by express, all expenses should be prepaid. Gum camphor, or some insecticide may be used in packing cocoons for market.

CHAPTER IX.

THE MOTHS OF THE SILK-WORMS.

In from ten to twenty days from spinning, the cocoons that were reserved for "seed," begin to show signs of life within.

The prisoner moistens one end of its cocoon with a secretion provided for the purpose, and generally breaks through the cocoon in the forenoon ; it then comes forth as a moth, with wet, limp wings.

The moths appear in greatest numbers from five to nine o'clock in the morning : they should be placed upon paper and left to dry and rest for a short time, the sexes being kept separate.

The moths now look no more like the former silk-worms that spun the cocoons, than did the swaddled-up chrysalides.

The moth is of a creamy or grayish-white color, with brownish markings across the wings. It has four wings ; it has no desire to spin, and the former appetite for Mulberry leaves has departed. After a short time, when the wings are thoroughly dried, the moths should be placed upon clean paper or muslin, upon a flat surface. If the eggs are intended for sale, this paper or muslin should be previously weighed and the accurate weight marked upon one side ; then, after the eggs are upon the paper and have dried a few days, the paper or muslin should again be weighed and marked, when the difference between the markings will show the weight of the eggs.

The male moth is smaller and more active than the female, and keeps up a constant flutter with his wings, but neither sex attempts much flying.

That the eggs may be impregnated, an equal number of the sexes should be placed upon the paper together, for six or eight hours, in a darkened room. Superfluous

males should be placed in a box, to await the females that may appear the next morning from the cocoons.

At the end of six or eight hours, the sexes should be separated, and the females alone left in possession of the paper in the dark, for twenty-four hours, during which time they will lay their eggs. Each female lays from two hundred to four hundred eggs, perhaps averaging three hundred. The yellow eggs gradually turn to a drab or grayish color, if impregnated; but if they remain of the original color for a month, they are probably worthless for seed, and may be destroyed.

The moths live three or four days, sometimes a week longer, and then die of old age in less than three months from their own birth, from the tiny eggs.

If the eggs are not to be sold, they should be kept through the winter in perforated tin cans or boxes; the holes should be covered with fine wire cloth, to keep out insects. The perforation is to give necessary air to the eggs that would probably become worthless in air-tight vessels. The eggs must be kept in a cool place. Even with the thermometer down to nearly freezing point, the eggs are said to be uninjured. But do not freeze them.

Premature hatching must be avoided; that is, before the Mulberry leaves are ready for food, the box of eggs must be kept on ice, if necessary, to prevent hatching too early in the spring. But do not place them on ice when they have begun to hatch, or it will kill them.

There should be no dampness in the room, closet, or cellar where the eggs remain, and the eggs should be looked after occasionally, to see that no insects have got within the box or tin, or that no mould is destroying the eggs. Keep up the temperature while the moths are laying their eggs. When necessary to remove moths, do so by taking hold of the wings carefully.

CHAPTER X.

VARIETIES OF SILK-WORMS.

The worm that feeds upon the Mulberry was originally derived from the northern provinces of China. But changes have been made by climate, food, and artificial surroundings to such a degree, that there are at the present time varieties of silk-worms that vary in respect to the color and shape of their cocoons, in regard to the quality of silk produced, and in the number of broods produced each year.

Among the different varieties are the *Annuals*, *Bivoltines*, *Trivoltines*, *Quadrivoltines*; producing one, two, three, and four broods each year. It is generally conceded that the annuals, are the most profitable for silk growers. The *Bivoltines* produce two broods, but the second brood is seldom raised, because the eggs hatch at a time when Mulberry food is scarce. The *Trivoltines* are said to moult but three times, instead of four, as is usual with the annuals.

Varieties are often named after the countries where they thrive best. Among these are the French, producing yellow and straw-colored, large cocoons; Italian, a smaller, but fine, yellow cocoon; Chinese, a white cocoon; Japanese, green and white in color; Turkish, producing in Europe the best kind of white cocoons.

The most healthy and most vigorous varieties of silk-worms produce yellow or straw-colored cocoons; but white ones are considered more valuable in commerce. A silk grower must select the variety which he prefers; but for beginners, probably the yellow-colored cocoon is preferable.

CHAPTER XI.

DISEASES OF THE SILK-WORM.

Probably every animal, insect, or worm that walks, flies, or crawls, is subject to disease in some form, and the silk-worm is no exception. Some of these diseases are caused by too great heat, others by cold, while some are hereditary. One of the worst diseases that the French silk growers have had to contend with, is "Muscardine." The losses in some years, in French cocooneries, have been estimated at one-sixth of the profits. The worms, in this disease, become a dullish white, the bodies become soft, and all the movements of the worms are sluggish, and they soon die. Bassi, an Italian, found the disease to be due to the attack of a fungus.

"Pebrine," another scourge, is hereditary. It is called *Pebrine* on account of the dark spots which appear on the worms, "peppering" the skin. This disease has been compared to the Asiatic cholera, and it may become contagious and infectious; it was unknown until the year 1842.

Another disease, called *Flacherie*, is supposed to be caused by fermentation of food in the stomach of the worm, resulting in the development of fungi.

There are other diseases; but as no silk-worm physician has yet appeared who could cure these silk-worm patients, a long list of diseases can be of no practical benefit. Those enumerated are considered the most fatal.

Much, however, may be accomplished by silk growers in *preventing* disease. The first thing is, to preserve none but healthy eggs, and then by great care, good ventilation, cleanliness, and plentiful food, to keep the worms in a healthy state.

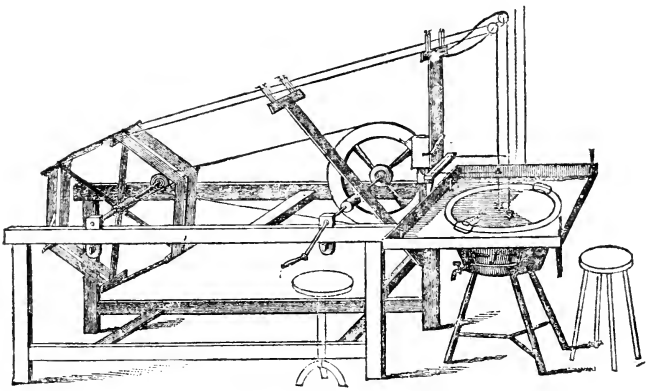
CHAPTER XII.

REELING.

Great skill is required to reel silk in a proper manner. This labor may be performed at home; but, in order to have the silk marketable, this work should be done by trained reelers. Where there are "filatures," it is much better to send the cocoons to them for reeling. Raw silk is produced by the operation of winding off several of the cocoons at the same time on a common reel, thus making one even thread. Raw silk is divided into three forms: "Organzine," "Floss," and "Tram." "Organzine" is the best, being well twisted; "Floss" is loose silk that has to be carded before it is spun, while "Tram" is not well twisted and the poorer cocoons are used for making it.

Before the cocoons can be reeled, they are placed in a basin of hot, nearly boiling water, to soften the natural gum of the filament. They are then moved about and slightly beaten with a small birch or corn broom, that the ends of the threads may be found. The ends of the threads get caught in the extremities of the splinters of which the broom is made, and then the reeler shakes the cocoons until each hangs by a single thread. Five or more of the threads are introduced into a hole or glass bead of the *filiere* on one side of the frame of the reel, and five more threads are put into a hole upon the other side; the threads or two strands are then brought together, crossed, rolled, and twisted several times, and after other crossings and re-crossings, not necessary to mention, the silk from the cocoons at length gets safely deposited upon the reel. It often takes about four pounds of cocoons to reel one pound of raw silk. The machinery employed for silk-reeling is possibly the nearest perfection in Italy and France.

Reeling, although requiring skill, is a neat, agreeable work, and very appropriate for the deft fingers of young women. In a filature recently visited, several young girls were sitting before filled basins of nearly boiling water.



IMPROVED LOMBARDY HAND REEL.

The basins were stationary, made of tin or copper, and a little larger than the common set water basins of our houses.

A steam engine in the story below supplied the power for working the reel, and the water was also kept hot by means of the steam brought in pipes for the purpose, from the same engine. When the water, in reeling, is allowed to get too cool, the cocoons unwind with difficulty, and the silk breaks.

The reels used in different countries, though upon the same general principle, vary in details of structure. Above is an engraving of an Improved Lombardy Hand Reel, which is regarded as being as good as any in use.

CHAPTER XIII.

CHEMISTRY OF SILK.

To philosophical minds there is nothing more curious or wonderful than the change of the green Mulberry leaves, through the agency of a mere worm, into the soft, smooth silk, with which queens and empresses are pleased to adorn themselves.

It would save much labor and doubtless be a boon to mankind, could some way be devised for converting the Mulberry into silk, without the aid of the worm; but no chemists have yet been able to obtain this result. However, they inform us that the fibers of silk are chiefly composed of a substance called *sericine*, mixed with albumen, and that this substance is covered with wax that is removed by successive boilings with alcohol, water, acetic acid, and water again.

This pure *sericine* sinks in water, is white, and of a lustre like silk, but it does not turn yellow by nitric acid, like other albuminous animal tissue. Mr. Mulder found no sulphur in *sericine*, but carbon 49.11, hydrogen 6.5, oxygen 26.72, and nitrogen 17.67.

Raw silk is low in price, while manufactured is high. One great cause of manufactured silk being so costly, is found in the great loss from imported silk. There is twenty-five per cent. of gum in the fiber, which has to be removed before drying, and the remaining waste of fifteen per cent. is the result of the many different processes which silk passes through in being manufactured. Therefore there is a total loss of forty per cent. which the manufacturer must take into account in buying, besides adulterations often found in Chinese silk. Fifteen different operations are necessary after taking the silk from the reel, before a single spool of silk is ready for the market.

CHAPTER XIV.

MISCELLANEOUS.

The silk culturist has found no royal highway to fortune. The agriculturist is not invited to leave his farm untilled, and make silk-growing a special business. Rather, let it be looked upon in the light that butter-making or poultry-raising is, simply as making one more avenue for bringing a needed income from the farm.

In foreign countries, silk is mostly raised by women and children ; each family raising as many worms as possible, without interfering with more profitable employment. But, in the aggregate, silk culture has been of immense benefit to the countries of Japan, China, France, and Italy. There is no reasonable doubt, but with equal industry and perseverance, silk culture may become of equal benefit to American farmers, and of immense value to our nation.

Let the farmer set out a small Mulberry grove, or hedge, near his home. When two years old, let him purchase in Washington, Philadelphia, or some other market, a few silk-worms' eggs and a manual of instruction in silk culture, and after presenting them to his wife, await the results of her experience. Doubtless, she will not make more the first year, than the cost of the eggs and book ; but it is a new business, and there is much to learn. Her experience will be of great value the following year, when she may, with the aid of growing children to pick the leaves, raise fifty-thousand worms ; and, if successful, expect some return for her labor, perhaps twenty-five or fifty dollars, or even more, but depending upon the market.

The present year our Government has seen fit to aid this struggling industry so far as to establish experi-

mental stations in such States as are best adapted by soil and climate to the raising of the silk-worm. Filatures will be opened, and Mulberry trees planted near them.

Millions of dollars that might be paid to our own agriculturists, if they were only practical silk growers, are yearly sent to foreign countries, to purchase raw silk. The right soil and climate for raising the silk, may be found in many States of the Union, and there are thousands of inhabitants who might be materially benefited by earning a few dollars each year in this light and interesting employment. Why not try it? Go into the business moderately at first; then, if not successful, there will be but little loss.

In California, the Legislature has aided silk culture by opening a filature, where young ladies may learn to reel, and where cocoons raised in the State are bought. The United States Government has also established an "experimental station" recently, at Piedmont, about three miles from Oakland, in the foot hills of the coast mountains. On visiting the site, one may find the wooden two-story building upon a sloping hillside, facing the south, and partially surrounded by a grove of Eucalyptus trees. The soil is well adapted to the growth of the Mulberry, and the steep hillside will soon be covered with hundreds of trees suitable for food for the silk-worm. When the building is finished, and this industry is firmly established, it is believed that silk may be produced that cannot be excelled by foreign countries. At present, there are filatures and markets open in several States where Mulberry trees, seeds, cuttings, and eggs are sold, and where cocoons are bought from culturists. The Philadelphia Silk Culture Association, also, has reels for sale. Eggs are usually sold at about one dollar per thousand; but market prices vary. At Washington, D. C., San Francisco, and in other cities, doubtless, eggs may be purchased upon application.

When agriculturists awaken to the importance of silk culture, and, through the aid of Government, filatures and markets are established all over our land, then, it is believed, that the growing of raw silk will take the prominence that its importance demands, and that silk culture will eventually prove one of the great industries of the United States, and amply pay the silk culturist for his labor.

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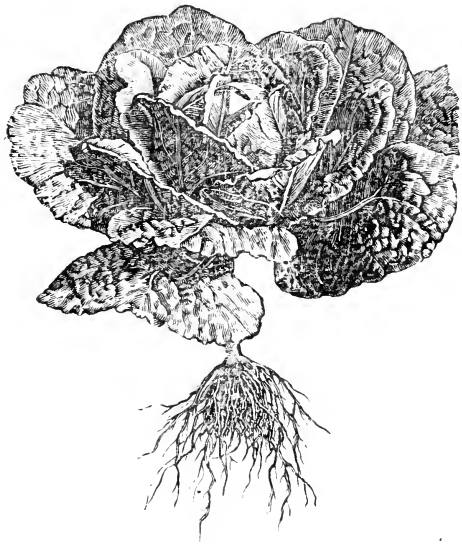

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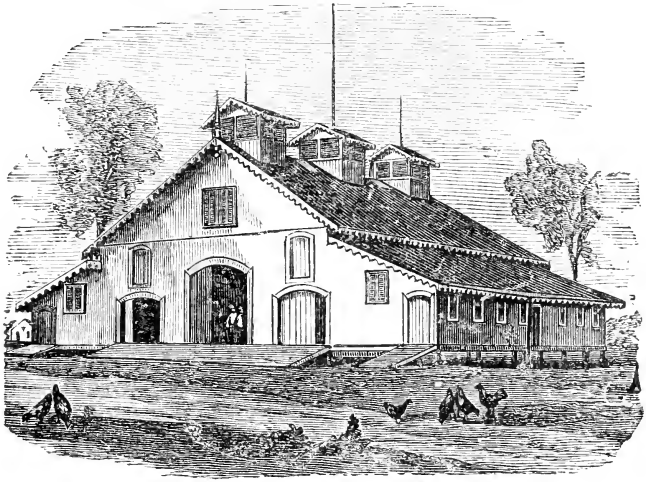

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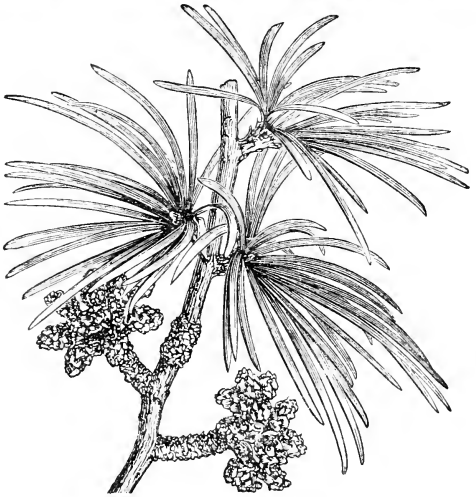

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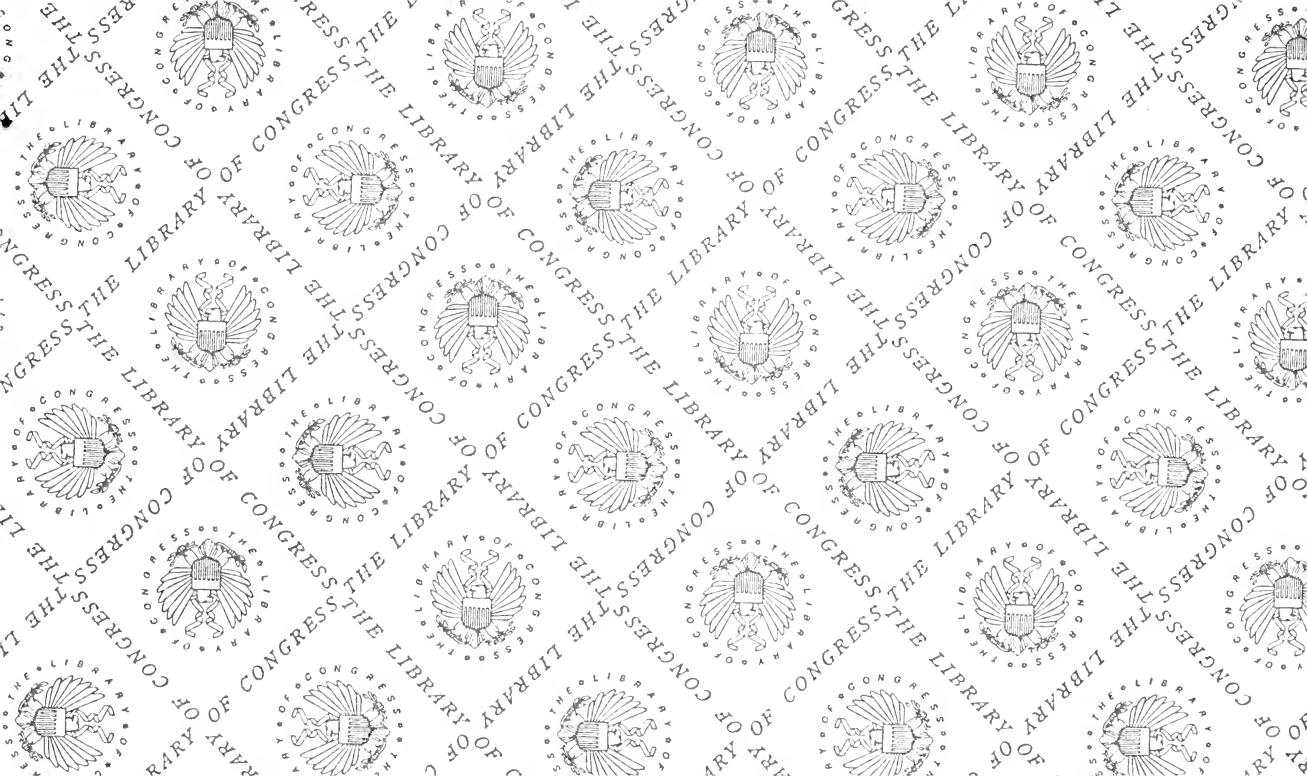
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